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ENERGY DEPARTMENT INVESTS $3 MILLION TO TRAIN FUTURE ENERGY SCIENTISTS

The U.S. Department of Energy (DOE) today announced it will invest a total of $3 million in nine projects selected under its University Training and Research (UTR) program, which awards research-based educational grants to U.S. universities and colleges in areas that promote Office of Fossil Energy goals.

UTR is the umbrella program under which the Department's University Coal Research (UCR) and Historically Black Colleges and Universities and Other Minority Institutions (HBCU/OMI) initiatives operate. The two initiatives address pressing scientific and technical energy challenges while also building our nation's capabilities in energy science and engineering by providing hands-on research experience to future generations of scientists and engineers.

The selected research projects fall under three key topic areas:

- *Sensors and Controls*—Developing new classes of measurement tools to manage complexity; permit low-cost, robust monitoring; and enable real-time optimization of fully integrated, highly efficient power-generation systems.
- *Water Management Research and Development*—Advancing technologies to reduce the amount of freshwater used by power plants and minimizing any potential impacts of plant operations on water quality.
- *High-Performance Materials*—Investigating structural materials to lower the cost and improve the performance of fossil fuel–based power-generation systems, and developing computational tools in predictive performance, failure mechanisms, and molecular design of materials.

The nine projects will be managed by the Office of Fossil Energy's National Energy Technology Laboratory. Descriptions of the projects are shown below:

Topic Area: Sensors and Controls

Raman Spectroscopy for the On-Line Analysis of Oxidation States of Oxygen Carrier Particles—In this UCR project, researchers at Washington State University (Pullman, WA) will develop an online optical sensor to measure the oxidation state of oxygen-carrier particles such as iron oxides, copper oxides, and calcium sulfates and will then demonstrate its feasibility. Knowing the oxidation states of the oxygen carriers will provide in situ information that can be used to make adjustments to optimize future power-generation technologies such as chemical looping reactors. DOE funding: $400,000.

Investigation of High Temperature Silica Based Fiber Optic Sensor Materials—Virginia Polytechnic Institute and State University (Blacksburg, VA) will lead an investigation into the high-temperature stability of state-of-the-art fused silica optical fibers and the impact of the fused silica material properties on performance. The results obtained from this UCR project will provide the roadmap and design approach needed for optical fiber sensor materials breakthrough in the performance barriers that limit the deployment of optical fiber sensors in harsh environments. DOE funding: $400,000.

Additive Manufacturing of Energy Harvesting Material System for Active Wireless MEMS Sensors—The University of Texas at El Paso (El Paso, TX) and its collaborators will design, fabricate, and evaluate an energy-harvesting material system capable of working up to

1,000°C to harvest both vibrational and thermal energy. Results obtained from this HBCU-OMI project could lead to the discovery of a new energy-harvesting material design paradigm compatible with harsh environments to power high-temperature, wireless micro-electromechanical system (MEMS) sensors. DOE funding: $250,000.

Topic Area: Water Management Research and Development

Continuous Water Quality Sensing for Flue Gas Desulfurization Wastewater—In this UCR project, the University of Alabama at Birmingham (Birmingham, AL) will develop an integrated water-sensor package capable of measuring multiple contaminants and common water quality indicators, such as pH and temperature. The proof-of-concept prototype will be integrated with a commercial, off-the-shelf trace-metal-concentration measurement device to accurately detect trace metal concentrations on a real-time, continuous basis. The resulting demonstration unit will be used for extended in-field testing of flue gas desulfurization wastewaters at a coal-fired power plant, where it will also be validated for accuracy and reliability. The unit is expected to reduce off-site laboratory analysis costs and provide a high level of confidence in compliance with EPA discharge guidelines. DOE funding: $399,986.

Developing Cost Effective Biological Removal Technology for Selenium and Nitrate from Flue Gas Desulfurization Wastewater from an Existing Power Generating Facility—West Virginia State University (WVSU) Research and Development Corporation (Institute, WV) will investigate and determine a technically feasible and cost-effective process for designing photosynthetic organisms capable of sequestering selenium and nitrates from flue gas desulfurization (FGD) wastewater. The results obtained from this HBCU/OMI project will assist in maximizing the sequestration of selenium and nitrates in biomass, thereby lowering the need for FGD wastewater remediation, reducing the amount of freshwater used by power plants, and enhancing agricultural production. DOE funding: $249,999.

Topic Area: High Performance Materials

Development of a Physically Based Creep Model Incorporating Eta Phase Evolution for Nickel-Base Superalloys Used in Advanced Electric Power Generation Plants—Researchers at Michigan Technological University (Houghton, MI) will develop a physically-based creep model for the nickel-based superalloy Nimonic® 263. In materials science, "creep" refers to the tendency of a solid material to deform under mechanical stress. With a physical understanding of creep deformation and failure mechanisms as a function of eta phase fraction and morphology, existing creep models will be modified to include this important aspect of microstructural instability. The results obtained in this UCR project will enhance life prediction, component design, and alloy selection for advanced fossil-energy power plants. DOE funding: $399,996.

Integrated Computational Materials Engineering for Creep of Nickel-Base Superalloys in Advanced Ultra-Supercritical Steam Turbines—The Ohio State University (Columbus, OH) will develop new modeling capabilities to predict long-term creep behavior of nickel-base superalloys used in advanced ultra-supercritical (A-USC) steam turbines. The integrated computational materials engineering (ICME) approach used by the researchers in this UCR project will improve the efficiency and accuracy of assessing the alloy's long-term creep performance, thereby accelerating the development of next- generation materials for A-USC steam turbines. This will allow U.S. manufacturers to maintain a competitive edge in building highly efficient coal-fired power plants. DOE funding: $400,000.

The Fundamental Creep Behavior Model of Gr.91 Alloy by Integrated Computational Materials Engineering Approach—Researchers at Florida International University (Miami, FL) will utilize the integrated computational materials engineering (ICME) approach to investigate the fundamental creep cracking mechanism of Gr.91 alloys under the operating conditions found in advanced fossil fuel–fired power plants and establish the link between composition, processing parameters, phase stability, microstructure, and creep resistance. At the end of this HBCU/OMI project, a model based on computational thermodynamics and kinetics will be developed to provide guidance on how to improve the creep resistance of Gr.91 alloys. DOE funding: $250,000.

A Guideline for the Assessment of Uniaxial Creep and Creep-Fatigue Data and Models—In this HBCU/OMI project, the University of Texas at El Paso (El Paso, TX) will develop an aggregated database of creep and creep-fatigue validation data from existing datasets for P91 steel and 316 stainless steel. The database will be used to benchmark the creep and creep-fatigue models results obtained into a variety of finite element models. The performance of the models will be evaluated with respect to experiment uncertainty and the repeatability and stability of extrapolations using the models will be tested across boundary conditions and regimes. Using the resulting guidelines developed, a component designer will be able to easily select the best constitutive model(s) and experimental datasets for intended designs. DOE funding: $250,000.